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Toxic Substance Storage Tank Containment Assurance and Safety Program Guidelines for Application of Technical Codes for Hazardous Materials Storage Tanks

Maryland Dept. of Health and Mental Hygiene
Baltimore

Prepared for

Environmental Protection Agency, Washington, DC

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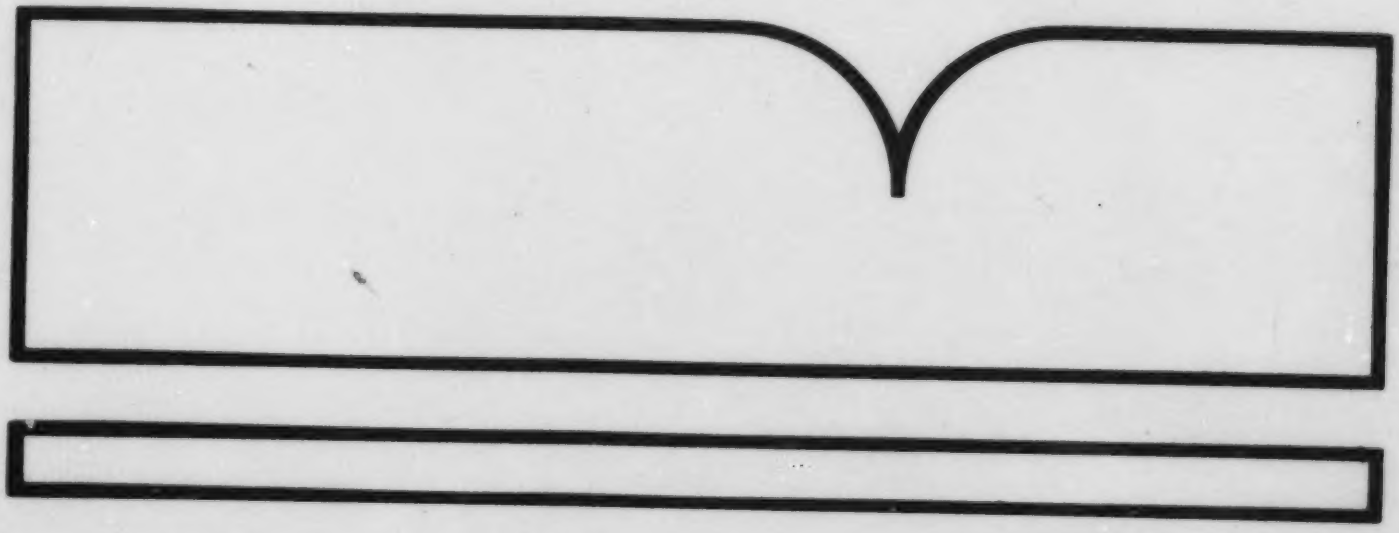

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TOXIC SUBSTANCE STORAGE TANK CONTAINMENT ASSURANCE AND SAFETY PROGRAM

GUIDELINES FOR APPLICATION OF TECHNICAL CODES FOR HAZARDOUS MATERIALS STORAGE TANKS

MARYLAND DEPARTMENT OF
HEALTH AND MENTAL HYGIENE

STATE OF MARYLAND
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
OFFICE OF ENVIRONMENTAL PROGRAMS
SCIENCE AND HEALTH ADVISORY GROUP

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This document brings together a listing, by reference, of appropriate technical codes dealing with storage tank design, construction and use, as promulgated by the American Petroleum Institute, the National Fire Protection Association, American Society of Mechanical Engineers, American Water Works Association, American Concrete Institute, the National Association of Corrosion Engineers and the Steel Structures Painting Institute. It further identifies each reference as being either a standard, specification, recommended practice, bulletin or publication, and indicates whether the cited code is applicable to atmospheric, low pressure or high pressure tanks. Certain Underwriters Laboratories are also cited.

Because public regulatory agencies derive the data upon which they promulgate restrictive measures from existing standards, codes and recommended practices, the Code document suggests, inferentially, that the user consult all appropriate and applicable codes in order to make certain, in advance, that his installation will be in compliance with any legal restriction which could be cited by an inspector.

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TOXIC SUBSTANCE STORAGE TANK CONTAINMENT ASSURANCE AND SAFETY PROGRAM: GUIDELINES FOR APPLICATION OF TECHNICAL CODES FOR HAZARDOUS MATERIALS STORAGE TANKS

PREPARED UNDER
U.S. ENVIRONMENTAL PROTECTION AGENCY
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TOXIC SUBSTANCES CONTROL ACT

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FOR:

STATE OF MARYLAND
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
OFFICE OF ENVIRONMENTAL PROGRAMS
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BALTIMORE, MARYLAND 21201

SEPTEMBER 1983

DISCLAIMER

This report has been reviewed by the State of Maryland Department of Health and Mental Hygiene, Office of Environmental Programs, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Department of Health and Mental Hygiene, or the United States Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Because hazardous materials vary widely in their characteristics and in the manner in which they should be stored, the material contained within this Manual can serve only as a guide. It is the responsibility of the storage facility owner to seek the assistance of appropriately qualified professionals with the necessary skills to design a storage system which can be used safely, and which provides the necessary measures for public and environmental protection.

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- Department of Health and Mental Hygiene
  - Office of Environmental Programs
    - Air Management Administration
    - Waste Management Administration
    - Science and Health Advisory Group
- Department of Public Safety and Correctional Services
  - State Fire Marshall's Office
- Department of Natural Resources
  - Water Resources Administration
- Department of Licensing and Regulation
  - Maryland Occupational Safety and Health Administration

also,

- Maryland Casualty Company, Baltimore

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SECTION 1

INTRODUCTION

Over the years, technical codes have been developed by independent trade organizations to standardize materials, design, fabrication, and inspection methodologies in a variety of industrial areas. These codes delineate acceptable and desirable practices an industry should follow to attain uniform quality and safety in its operations. The general purpose of such codes is to ensure reasonable protection of life and property, and to adequately limit in-service product deterioration, so as to provide a reasonably long and safe period of usefulness. Adherence to such codes is not mandatory, however, unless they are specially adopted by a regulatory body.

Technical codes are generally developed by consensus of a committee within an independent or industrial organization. Such committees typically are composed of technically qualified representatives of producers, users, and general interest groups. When codes are adopted by a regulatory agency, representatives of that agency often are invited to participate in committee actions to ensure correspondence between the technical code and other regulations in effect in their jurisdiction. Engineers, designers, manufacturers, and inspectors should determine if the applicable state and local regulations differ from the technical codes they are based upon.

The technical codes promulgated by an organization take many forms which are variously called standards, specifications, or recommended practices. Standards, a term often used interchangeably with "code," is an inclusive term that designates the specifications, methods, definitions, classifications, or practices adopted by an organization. Standards are generally regarded as mandatory criteria with which a producer must comply if the product is to bear the organization's seal of approval. Specifications are a precise statement of the requirements to be satisfied by a material or product, and the procedures to ensure adherence to those requirements. The specifications are usually expressed numerically and incorporated directly or by reference in the technical standards. Recommended practices are procedures and specifications which are advisable in nature, not mandatory for gaining the sponsoring organization's approval.

Because the codes may be either more or less restrictive than needed for certain applications, their use is generally voluntary, and the mere existence of technical codes or standards does not preclude anyone from using, purchasing, manufacturing, or marketing products or procedures which do not conform to the standards. Frequently, technical codes will form the basis for regulatory control of a particular class or aspect of industry. In such cases a given technical code forms the standard which a governmental agency will impose through a

regulatory process. Commonly the agency will also adopt a program of licensing or inspection to insure that the provisions of those codes adopted through regulation are being met. Although technical codes cannot be construed as being binding in a regulatory or legal sense unless specifically adopted by a regulating agency, they may be a prerequisite to obtaining adequate insurance coverage.

SECTION 2

CODES APPLICABLE TO STORAGE TANKS

Ideally the application of technical codes should commence at the storage system design stage. Several codes detail the design and fabrication of storage tanks, and these constitute the acceptable industrial standards. These codes are typically applicable to specific tank types, tank contents, construction materials, construction methods, or types of appurtenances. Since there is much variability and overlap among the codes, design and inspection engineers should consult individual codes to determine their specific scope and limitations. Many of the major technical codes applicable to various aspects of storage system design are listed in Table 2-1. This table indicates the title and number of codes, and the types of tanks to which they apply.

2.1 ATMOSPHERIC TANKS

A series of specifications for steel atmospheric storage tanks has been developed by the American Petroleum Institute (API). These include:

- API Spec. 12 B, Bolted Production Tanks;
- API Spec. 12 D, Large Welded Production Tanks; and
- API Spec. 12 F, Small Welded Production Tanks.

Standards for aluminum tanks are covered by ANSI (American National Standards Institute) Standard B 96.1.

Many standards dealing with water handling and storage have been developed by the American Water Works Association (AWWA). Although these tanks are intended for water storage, they are applicable for storage of other liquids as well. Their standards include:

- AWWA D 100-67 - Standard for Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage;
- AWWA D 101-53 - Standard for Inspecting and Repairing Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage; and
- AWWA D 102-64 - Standard for Painting and Repainting Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage.

Underwriters Laboratories (UL) has developed standards which overlap those of API, but include tanks too small for API standards.

Table 2-1

MAJOR TECHNICAL CODES APPLICABLE TO STORAGE SYSTEMS

Organization - Code No.	Title	Applicable Tank Types
API Spec. 12B	Bolted tanks for storage of production liquids	A
API Spec. 12D	Field welded tanks for storage of production liquids	A
API Spec. 12F	Shop welded tanks for storage of production liquids	A
API RP 12RI	Setting, connecting, maintenance, and operation of lease tanks	A
API Std. 510	Pressure vessel inspection code	L, H
API RP 520	Design and installation of pressure-relieving systems in refineries	H
API RP 521	Pressure relief and depression systems	H
API Std. 526	Flanged steel safety relief valves	L, H
API Std. 620	Design and construction of large welded, low-pressure storage tanks	L
API Std. 650	Welded steel tanks for oil storage	A
API Publ. 1587	Waste oil round-up	A
API Publ. 1604	Abandonment or removal of used underground service station tanks	A
API Bull. 1615	Installation of underground petroleum storage systems	A
API Publ. 1621	Bulk liquid stock control at retail outlets	A
API Bull. 1623	Bulk liquid loss control in terminals and depots	A
API Bull. 1628	Underground spill clean-up manual	A, L, H
API Std. 2000	Venting atmospheric and low-pressure storage tanks	A, L
API RP 2001	Fire protection in refineries	A, L, H
API RP 2003	Protection against ignitions arising out of static, lightning, and stray currents	A, L, H
API Publ. 2009	Safe practices in gas and electric cutting and welding in refineries, gasoline plants, cycling plants, and petrochemical plants	A, L, H
API Publ. 2013	Cleaning Mobile tanks in flammable or combustible liquid service	A
API Publ. 2015	Cleaning petroleum storage tanks	A, L, H
API Publ. 2015A	A Guide for controlling the lead hazard associated with tank cleaning and entry	A, L, H
API Publ. 2023	Safe storage and handling of petroleum-derived asphalt products and crude oil residues	A
API Bull. 2202	Dismantling and disposing of steel from tanks which have contained leaded gasoline	A

Table 2-1 (Cont.)

Organization - Code No.			Title	Applicable Tank Types
API	Publ.	PSD-2207	Preparing tank bottoms for hot work	A, L, H
API	Std.	2510	Design and construction of LPG installations at marine terminals, natural gas plants, refineries, and tank farms	L, H
API	Bull.	2519	Use of internal floating covers and covered floating roofs to reduce evaporation loss.	A
API			Guide for Inspection of Refinery Equipment:	
			• Ch. II - Conditions causing deterioration or failures	A, L, H
			• Ch. III - General preliminary and preparatory work	A, L, H
			• Ch. IV - Inspection tools	A, L, H
			• Ch. V - Preparation of equipment for safe entry and work	A, L, H
			• Ch. VI - Pressure vessels	L, H
			• Ch. XI - Pipes, valves, and fittings	A, L, H
			• Ch. XII - Foundations, structures, and buildings	A, L, H
			• Ch. XIII - Atmospheric and low-pressure storage tanks	A, L
			• Ch. XIV - Electrical systems	A, L, H
			• Ch. XV - Instruments and control equipment	A, L, H
			• Ch. XVI - Pressure relieving devices	A, L, H
			• Ch. XVII - Auxiliary and miscellaneous equipment	A, L, H
			• Appendix - Inspection of welding	A, L, H
API			Guide for Follow-up Inspection of Interior Tank Coatings	A, L, H
NFPA		11	Foam extinguishing systems	A, L, H
NFPA		11A	High expansion foam systems	A, L, H
NFPA		11B	Synthetic foam and combined agent systems	A, L, H
NFPA		12	Carbon Dioxide extinguishing systems	A, L, H
NFPA		12A	Halogenated fire extinguishing agent systems	A, L, H
NFPA		16	Installation of foam-water sprinkler systems and foam-water spray systems	A, L, H
NFPA		17	Dry chemical extinguishing systems	A, L, H
NFPA		30	Code for flammable and combustible liquids	A, L, H
NFPA		43A	Liquid and solid oxidizing materials	A, L, H
NFPA		49	Hazardous chemical data	A, L, H

Table 2-1 (Cont.)

Organization	Code No.	Title	Applicable Tank Types
NFPA	58	Storage and handling of LPG	L, H
NFPA	59	Storage and handling of LPG at utility gas plants	L, H
NFPA	68	Explosion venting	A, L, H
NFPA	69	Explosion preventing systems	A, L, H
NFPA	70	National electrical code	A, L, H
NFPA	72A	Installation, maintenance, and use of local protective signaling systems	A, L, H
NFPA	72B	Installation, maintenance, and use of auxiliary protective signaling systems	A, L, H
NFPA	72C	Installation, maintenance, and use of remote protective signaling systems	A, L, H
NFPA	72D	Installation, maintenance, and use of proprietary protective signaling systems	A, L, H
NFPA	72E	Automatic fire detectors	A, L, H
NFPA	77	Recommended practice on static electricity	A, L, H
NFPA	78	Lightning protection code	A, L, H
NFPA	231	General indoor storage	A
NFPA	231A	General outdoor storage	A
NFPA	321	Classification of flammable and combustible liquids	A, L, H
NFPA	325M	Fire hazard properties of flammable liquids	A, L, H
NFPA	327	Cleaning small tanks and containers	A, L, H
NFPA	329	Underground leakage of flammable and combustible liquids	A, L, H
NFPA	419M	Code for explosive materials	A, L, H
NFPA	495	Identification of fire hazards of materials	A, L, H
NFPA	1221	Installation, maintenance, and use of public fire service communications	A, L, H
NFPA		Fire Protection Guide on Hazardous Materials	
ASME		Boiler and Pressure Vessel Code: o Section II - Materials specifications o Section V - Nondestructive examination o Section VIII - Pressure vessels o Section X - FRP Pressure vessels	L, H
AWWA	D100-67	Standard for steel tanks, standpipes, reservoirs, and elevated tanks for water storage	A
AWWA	D101-53	Standard for inspecting and repairing steel tanks, standpipes, reservoirs, and elevated tanks for water storage	A

Table 2-1 (Cont.)

Organization	Code No.	Title	Applicable Tank Types
AWWA	D102-64	Standard for painting and repainting steel tanks, standpipes, reservoirs, and elevated tanks for water storage	A
ACI		Guide for Protection of Concrete Against Chemical Attack by Means of Coatings and Other Corrosion-Resistant Materials	A, L, H
ACI		Manual of Concrete Practices	A, L, H
ACI	344	Design and construction of circular prestressed concrete structures	A, L, H
AIA		Fire Prevention Code	A, L, H
NACE	RP-01-69	Control of external corrosion on underground or submerged metallic piping systems	A, L, H
NACE	No. 1	Surface preparation for tank linings	A, L, H
NACE	No. 2	Surface preparation for some tank linings and heavy maintenance	A, L, H
NACE	No. 3	Surface preparation for maintenance	A, L, H
NACE	No. 4	Surface prepartion for very light maintenance	A, L, H
NACE	RP-03-72	Method for lining lease production tanks with coal tar epoxy	A, L, H
SSPC	5-63	White metal blast	A, L, H
SSPC	10-63	Near-white metal blast	A, L, H
SSPC	6-63	Commercial blast	A, L, H
SSPC	7-63	Brush off blast	A, L, H

LEGEND:

Organization:
- API = American Petroleum Institute
- NFPA = National Fire Protection Association
- ASME = American Society of Mechanical Engineers
- AWWA = American Water Works Association
- ACI = American Concrete Institute
- NACE = National Association of Corrosion Engineers
- SSPC = Steel Structures Painting Council

Code Number:
A numerical designation assigned to a code, etc., by the promulgating organization.
- Spec = specification
- RP = recommended practice
- Std = standard
- Publ. = publication
- Bull. = bulletin

Applicable Tank Types:
- A = Atmospheric
- L = Low Pressure
- H = High Pressure

Source: Ecology and Environment, Inc., 1983.

UL standards do not provide as much detail as API standards, and therefore put more responsibility on the designer to obtain guidance from other professional reference standards and guidelines. Two UL standards applicable to hazardous materials storage are:

- UL 58 - Steel Underground Tanks for Flammable and Combustible Liquids; and
- UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.

Other standards related to atmospheric tanks include:

- ANSI B31.3 - Petroleum Refinery Piping Code;
- API Standard 650 - Welded Steel Tanks for Oil Storage; and
- API Standard 2000 - Venting Atmospheric and Low-Pressure Storage Tanks.

2.2 LOW-PRESSURE TANKS

Vertical, cylindrical tanks with domed roofs which operate at pressures slightly above atmospheric pressure can be built according to API Standard 650. However, for tanks with more substantial operating pressures, up to 15 psig, API Standard 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, establishes the proper design criteria. Section VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code may provide useful design guidelines, although they are not directly applicable to tanks with operating pressures below 15 psig.

2.3 HIGH-PRESSURE TANKS

In general terms, a pressure vessel is a closed container of limited length which is subject to pressures above one or two pounds per square inch. For purposes of this discussion, a high-pressure tank or vessel is one with an operating pressure greater than 15 psig.

The most comprehensive standards for the design, fabrication, and inspection of high-pressure tanks is found in the ASME Boiler and Pressure Vessel Code. This is an 11-section publication that is issued every three years. Most states have passed regulations which make all or certain parts of the ASME Code legal requirements, and have inspectors to enforce provisions of the Code. Sections of the ASME Code applicable to the design and inspection of high-pressure storage tanks are:

- Section II - Material Specifications;
- Section V - Nondestructive Examination;
- Section VIII - Pressure Vessels, Division 1;
  Pressure Vessels, Division 2 - Alternative Rules;
- Section IX - Welding Qualifications; and
- Section X - Fiberglass-Reinforced Plastic Pressure Vessels.

Other codes pertinent to high-pressure storage systems have been developed by the American Petroleum Institute and the National Fire Protection Association. These include:

- API 510 - Pressure Vessel Inspection Code;
- API - Guide for the Inspection of Refinery Equipment, Chapter VI, Pressure Vessels;
- API Standard 2510 - Design and Construction of LP Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries, and Tank Farms;
- NFPA 58 - Liquefied Petroleum Gases, Storage and Handling;
- NFPA 59A - Liquefied Natural Gas, Storage and Handling; and
- NFPA 43C - Oxidizing Materials, Gaseous, Storage.

2.4 STORAGE TANK CONSTRUCTION MATERIALS

Selection of the appropriate tank materials is a critical element in the design of a hazardous materials storage system. Although literally thousands of codes exist for all types of construction materials, the scope of those standards and specifications does not necessarily address their application to hazardous materials storage. Therefore, the designer is advised to consult the codes, such as those identified in Sections 2.1 through 2.3, most applicable to the type of storage under consideration. The codes will generally identify, or give references to, pertinent materials standards. As an example, the base materials specifications in Parts A and B of the ASME Boiler and Pressure Vessel Code, Section II, are similar or identical to those of the American Society for Testing and Materials (ASTM). The design engineer may then refer to the cited ASTM standard for further details.

ASTM currently lists over 6,700 standards in its 66-volume, 16-section 1983 Annual Book of ASTM Standards (prior to 1983, the ASTM standards were published in 48 parts). Those sections containing material and procedural standards applicable to hazardous materials storage system design are:

- Section 1 - Iron and Steel Products;
- Section 2 - Nonferrous Metal Products;
- Section 3 - Metal Test Methods and Analytical Procedures;
- Section 6 - Paints, Related Coatings, and Aromatics;
- Section 8 - Plastics;
- Section 9 - Rubber;
- Section 11 - Water and Environmental Technology;

- Section 14 - General Methods and Instrumentation; and
- Section 15 - General Products, Chemical Specialties, and End Use Products.

A complete listing of ASTM standards and a cross reference between 1983 volumes and previous year part numbers may be obtained from:

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103
(215) 299-5462

Another source of design specifications frequently cited or incorporated in techincal codes is the American National Standards Institute (ANSI). This organization coordinates America's voluntary standards system, maintaining an inventory of over 11,000 American standards. ANSI also maintains the 6,000 standards promulgated by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Standards of the 71 national standardizing bodies of other countries cooperating within the ISO are stocked or obtainable by ANSI. Listings of available standards may be obtained from:

American National Standards Institute, Inc.
1430 Broadway
New York, New York 10018
(212) 354-3300

Further information about materials standards and specifications may be obtained from a variety of industry-specific organizations. These include:

American Petroleum Institute
2101 L Street, NW
Washington, DC 20037
(202) 457-7160

American Society of Mechanical Engineers
345 E. 47th Street
New York, NY 10017
(212) 705-7722

American Iron and Steel Institute
1000 16th Street, NW
Washington, DC 20036
(202) 452-7100

Steel Structures Painting Council
4400 5th Avenue
Pittsburgh, PA 15213
(412) 578-3327

National Association of Corrosion Engineers
1440 South Creek
Houston, TX 77084
(713) 492-0535

American Welding Society
2501 NW Seventh Street
Miami, FL 33125
(305) 642-7090

American Institute of Chemical Engineers
345 E. 45th Street
New York, NY 10017
(212) 705-7338

Steel Tank Institute
666 Dundee Road, Suite 705
Northbrook, IL 60062
(312) 498-1980

Society of the Plastics Industry
355 Lexington Avenue
New York, NY 10017
(212) 573-9400

Chemical Manufacturers Association
2501 M Street, NW
Washington, DC 20037
(202) 887-1100

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269
(617) 328-9230

Underwriters Laboratory, Inc.
333 Pfingston Road
Northbrook, IL 60062
(312) 272-8800

American Society for Metals
Metals Park, OH 44073
(216) 338-5151

It should be noted that materials specifications typically address general issues such as metal strength and ductility. Material selection data for more specific considerations, such as chemical compatibility, should be determined on a case-by-case basis according to the best professional judgement.

SECTION 3

USE AND INTERPRETATION OF TECHNICAL CODES

As previously indicated, technical codes are developed to delineate acceptable and desirable practices an industry should follow to attain uniform quality and safety in its products and operations. The codes are generally intended for use by design engineers and technically qualified inspectors, and consequently are often written in highly technical language. To most laymen, the sheer number of technical codes and their voluminous technical detail can make it impractical to gain a thorough understanding of the codes. However some guidance can be provided to simplify use of the codes.

The first step in code usage is to select the code or codes, such as those identified in Sections 2.1 to 2.4, most applicable to the subject under consideration. These codes are usually identified in their titles as "standards," "specifications," "recommended practices," or by other similar descriptives. It is necessary to understand the distinction between these terms, as discussed in Section 1, to understand the context of the various codes.

Upon identification of the codes to be studied, it is essential that the user thoroughly read the foreword, preface, and any other introductory remarks about the code. These sections usually provide valuable information about the basis and derivation of the codes, their purpose and intent, limits of application, disclaimers, dates of revision, etc., and clearly define the context within which the code should be interpreted.

The next step is to review the table of contents. Besides identifying the subject matters within the code, this will familiarize the reader with the format, nomenclature, and content subdivisions. This will be of aid later for cross-referencing between subsections. Note the presence and contents of any appendices. Often the appendices contain additional standards or recommendations which would not otherwise be identified in a catalog of technical code titles, and they may also include definitions or other information which would be beneficial to read before reading the actual technical standards.

At this point, the reader should be able to identify the section and subsections of the code dealing with subjects of interest. However, it is still important to read the introductory paragraphs of the individual sections to determine the scope and limitations of those sections.

A consistent format is used throughout most codes to designate each of the sections, subsections, or paragraphs within the code. These designations may be in the form of letters, numbers, or a combination of both, arranged in sequential order. Each subsection is identified by the section designator, followed by a hyphen or period and a number in sequence (e.g., A-1, A-2; 2.1, 2.2, 2.3, etc.). This

facilitates reference to particular paragraphs or subsections without the need for extensive page references.

Once the proper code has been identified, and all applicable introductory and background information has been read, use of the code is simply a matter of reading the standards, referring to the proper cross references, and correctly interpreting what is written.

The use of four technical codes which provide the most information in the design, fabrication, and inspection of hazardous materials storage tanks are described in the following sections.

3.1 API STANDARDS AND SPECIFICATIONS

The American Petroleum Institute (API) has published hundreds of documents relevant to the production and refining of oil and petroleum products. Although originally developed for the petroleum industry, these standards can be applicable to most hazardous materials storage issues, provided that such specific issues as chemical compatibility are properly addressed and incorporated by the designer.

API codes are usually referred to as either "standards" or "specifications." According to API interpretations, these terms generally are identical in meaning. The use of one term or the other depends on the API division which developed the code. The API Production Department's codes are referred to as "specifications," and are generally applicable to atmospheric storage tanks for production fluids. "Standards" are promulgated by the API Refining Department, and are applicable to low- and high-pressure tanks.

Both API standards and specifications are designated by number, with subsection indicated sequentially by decimal places. Cross-references to standards within the same code document are designated by the paragraph or subsection number only. References to other API codes are made by title and number of the other reference. Material specifications are usually handled by referencing (by number and title) the appropriate ASTM or ANSI standards, unless API data is incorporated directly into the code.

In addition to its standards and specifications, API also publishes various recommended practices, bulletins, and publications. These documents do not set forth specific criteria or minimum standards that tank designs must meet before receiving API approval. However, they are useful as sources of further information about problems, hazards, or other practices related to the standards and specifications.

3.2 NATIONAL FIRE CODES

The National Fire Codes are an annual, 16-volume publication of the National Fire Protection Association (NFPA). These volumes are compilations of various individual codes, standards, recommended practices, manuals, guides, and model laws prepared by the NFPA. Only those documents which have been adopted by NFPA are included in the National Fire Codes.

Volumes 1 through 12 of the National Fire Codes contain NFPA codes and standards judged suitable for legal adoption and enforcement by government agencies. Volumes 13 through 16 contain recommended practices, manuals, and guides identifying good engineering practices. These volumes also include model laws and enabling acts which may be of help to regulatory bodies. Many of the NFPA documents have been approved as standards by ANSI.

Most of the documents in the National Fire Codes are available as separate pamphlets. A complete listing of these is found in the inside front and back covers of each volume of the National Fire Codes. This listing identifies the document's NFPA Code Number and the National Fire Codes volume number in which the listed title of interest may be found. This listing is suggested as the starting point for locating applicable NFPA standards.

Use of the NFPA codes is similar to the use of API codes. Each code is divided into chapters covering different elements of the code. The chapters are then divided into subsections indicated by the chapter number, a hyphen, and sequential subsection numbers. Paragraphs within each subsection are further indicated by sequential decimal places following the subsection number. For example, NFPA 30, Flammable and Combustible Liquids Code, contains:

CHAPTER 2 TANK STORAGE

2-1 Design and Construction of Tanks
2-1.1 Materials
2-1.2 Fabrication
2-1.2.1 (Paragraph 1)
2-1.2.2 (Paragraph 2)

Pages within the code are indicated by sequential page numbers preceded by the code number (e.g., page 30-17). References to other portions of the same code are indicated by only the section, subsection, or paragraph numbers. References to other codes refer to the title and number of the other code.

3.3 ASTM STANDARDS

The 1983 Annual Book of ASTM Standards contains over 6,700 current standards, divided into 16 sections of related subject areas. These sections are published in 66 volumes which further subdivide standards for related items. (Prior to 1983, the ASTM Standards were published in 48 parts.) Location of applicable ASTM standards is facilitated by use of the index, Section 00 (Part 48 in pre-1983 editions).

The index provides a listing of ASTM Standards by subject and by ASTM's alphanumeric code listing. The main subject entries refer to subjects taken directly from the scope of the standard, or they may highlight similar standards. In either case, the subject listing will be followed by the standard number in parentheses, and the number of the section where it may be found. Cross references within the index guide the user from related terms to the listed subject entries. These cross references are designated as "See" or "See Also" (or Sa) written in italics.

Each adopted or tentative ASTM standard has an individual serial designation listed in the alphanumeric index. This consists of a capital letter, a serial number of one to four digits, a hyphen, and a two-digit number indicating the year of adoption or latest revision. The letter at the beginning of the serial number indicates the general classification of the standard:

A = Ferrous Metals,
B = Nonferrous Metals;

C = Cementitious, Ceramic, Concrete, and Masonry Materials;
D = Miscellaneous Material;
E = Miscellaneous Subjects;
F = Materials for Specific Applications;
G = Corrosion, Deterioration, and Degradation of Materials; and
ES = Emergency Standards.

The serial number may be followed by a lower case letter which denotes a revision occurring in the same year as the year of adoption or latest revision. A capital letter "T" at the end of the standard is used to denote a tentative standard. The letter "M" after the serial number designates a standard in metric units.

The standard number may be followed by a number in parentheses, which indicates the year the standard was last reapproved. As an example, A236-69a (1974) refers to a specification for carbon steel forgings for railway use, first adopted in 1969, indicated by the "69" after the hyphen; then revised in 1969, indicated by the letter "a"; and reapproved in 1974, indicated by that date in parentheses.

The title is given following the standard's serial designation. A boldface number following the title indicates the volume in which the standard may be found.

The ASTM standards are cited frequently as design criteria by such organizations as API or ASME. When cited, the complete designation of standard number and title is usally given. The alphanumeric index may be used to locate the specific reference.

3.4 ASME BOILER AND PRESSURE VESSEL CODE

The American Society of Mechanical Engineers wrote the ASME Boiler and Pressure Vessel Code to provide rules for the design, fabrication, and inspection of boilers and pressure vessels. The ASME Code is written by a large Boiler and Pressure Vessel Committee and several subcommittees composed of engineers appointed by ASME. The Code Committee meets regularly to review the Code and to consider requests for its interpretation or revision. Interpretations and special provisions adopted by the committee are published in "Mechanical Engineering," and in a supplement to the ASME Code entitled "Code Cases."

By itself, the ASME Code has no legal status. However, most states have adopted at least parts of the Code as their legal requirements, and employ inspectors to enforce provisions of the Code. A new edition of the ASME Code is issued every three years, with the latest edition scheduled for 1983. Addenda to the Code are published semiannually between editions. Although ASME considers any edition of the Code to be adequate, certain issues of the Code may be specified as legal requirements by some regulatory bodies.

The chief inspectors of all states and municipalities which have adopted the code form the National Board of Boiler and Pressure Vessel Inspectors. The Board promotes uniform enforcement of Code rules by examining and commissioning inspectors. Qualified inspectors employed by a state, municipality, or insurance company may inspect a pressure vessel and permit it to be stamped "ASME-N.B." (The "N.B." stands for "National Board"). A vessel bearing the "N.B." stamp and registered with the National Board generally may be used and sold in any state. Inspectors employed by a vessel user may only use the ASME stamp, which somewhat limits the use of those vessels.

As indicated in Section 2.3, the ASME Code is published in 11 Sections. The user of the code should begin with the section title deemed most likely to cover the subject of interest. For storage applications, "Section VIII, Pressure Vessels, Division 1," and "Pressure Vessels, Division 2, Alternative Rules" would be the most likely starting point. Division 1 is the Pressure Vessel Code as it has existed in the past. Division 2 was developed as a means of permitting higher design stresses while ensuring at least as great a degree of safety as Division 1.

Section VIII, Division 1 is divided into three subsections: A, General Requirements; B, Fabrication Methods; and C, Materials of Construction. These subsections are further divided into a total of 13 Parts, which are designated by two letters, the first of which is "U" for "unfired." These are followed by two groups of appendices. The mandatory appendices, indicated by Roman numerals, detail procedures frequently referred to in the ASME Code. The non-mandatory appendices, designated by capital letters, provide information and suggested procedures which are not essential, but may be helpful to Code users. Of particular help to someone new to the Code are Appendices III and L. Appendix III defines many of the terms used in the Code, and is a good starting point for a first-time user. Appendix L provides sample problems illustrating application of Code formulas and rules, and is useful to the novice designer.

Section VIII, Division 2 is more sophisticated than Division 1, and requires a more technically competent engineer to use it. Division 1 employs a safety factor of about 4 in its standards, but ignores many secondary stresses which act in the vessel. Division 2 allows higher stresses, but requires thorough stress analysis and closer quality control of materials and fabrication.

Because of the extensive nature of the ASME Code, the user is advised to pay particular attention to background information, tables of contents, and indices (found at the end of each section) before using the Code. Although the style of designating parts, subsections, or articles may vary from section to section, each designation is unique, and cross-referencing within a section is accomplished rather easily. References to other sections of the Code will include the title and section number.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

As discussed in Section 3, technical codes are quite complex, and often difficult to understand. They provide a tremendous amount of technical detail which may easily overwhelm the user if the codes are not approached systematically. This requires selection of the appropriate code with which to begin the search for information.

As illustrated by Table 2-1, there are many technical codes applicable to specific aspects of hazardous materials storage systems. Selection of the inappropriate code may result in failure to determine standards specifically applicable to the problem at hand, and it may lead to an unnecessarily laborious search for the correct information. Therefore, selection of the code which appears to offer the broadest coverage of the subject of interest will either provide the information sought or direct the user to other pertinent sources.

It is important to consult those codes promulgated by organizations most involved with the type of materials to be used. For example, Section 2.1 identified standards of the American Petroleum Institute and the American Water Works Association (AWWA) which are applicable to atmospheric storage tanks. Because of API's extensive experience with the petroleum and petrochemical industry, its codes could be expected to provide more information relevant to hazardous materials storage, whereas the AWWA standards would have much more limited application. Therefore, because of their relevance and broad scope, it is recommended that the designer searching for standards applicable to specific types of storage tanks begin the search with the following codes:

- API Specification 12D and API Standards 650 for atmospheric tanks;
- API Standard 620 for low-pressure tanks; and
- ASME Boiler and Pressure Vessel Code, Section VIII for high-pressure tanks.

These codes will in turn cross reference the appropriate codes for materials, appurtenances, etc.

Although it may seem obvious, elementary, and therefore, unnecessary, the foreword, table of contents, and introductory paragraphs must be read if the codes are to be properly understood. To the casual user reading the code for informational purposes, the introductory paragraphs describe the framework within which the code is applicable. To the designer, the introductory material may identify the scope and application of the code and other sources of valuable information.

Because codes are revised regularly, it is also important that the user consult the latest applicable edition.

Technical codes are written by and for technical experts within a particular field. Therefore, the technical language may be unfamiliar to some users. Interpretation of the code, and formulation of judgements based on those interpretations, should always be left to individuals technically qualified to make such interpretations.